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PATENT SPECIFICATION

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(72) Inventors FRANCIS NEIL WILSON and DEREK CHARLES ATTENBURROW

(54) STERILISATION OF WATER FOR NUTRIENT FILM SYSTEMS

(71) We, FISONS LIMITED, a British Company, of Fison House, 9 Grosvenor Street, London WIX 0AH, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a process and a composition for use therein.

It has been proposed to grow plants with their roots immersed in a flowing film of liquid containing plant nutrients. Typically, a shallow waterproof trough is formed and a film of aqueous nutrient solution flows through the trough, is collected, e.g. in a sump tank, and recycled, e.g. to a header tank, from whence it is fed back to the trough. During the cycle, water and nutrients are taken up by the plant and these require replacement before the nutrient solution is recycled. This is conveniently done in a mixing tank before the solution is recycled. Such a plant growth system is called hereinafter a nutrient film system.

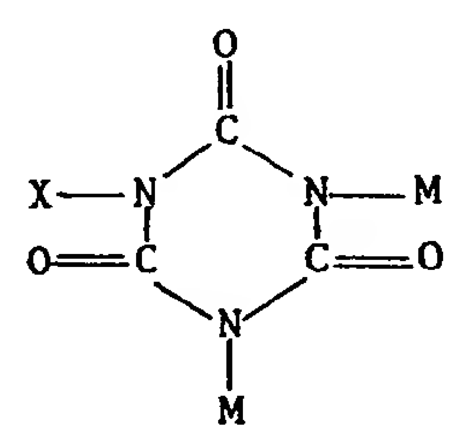
However, problems are encountered with such a system in that bacterial and other infections are rapidly transmitted from one plant to another throughout the system. We have devised a method and composition for reducing the risk of infection.

The present invention provides a process for treating water fed to or circulating in a nutrient film system which comprises incorporating a plant physiologically acceptable amount of a pathogenicide into the water.

The term pathogenicide is used herein to denote materials which not only kill plant pathogens, e.g. bacteria, fungi, algae and/or viruses, outright but which also inhibit growth and/or development of the plant pathogens so as to minimise any increase in infection. Thus the term pathogenicide includes pathogenistat materials.

Suitable pathogenicides for present use include halogen (e.g. chlorine or bromine), halogen donors, permanganates, and benzimidazole and other fungicides (e.g. carbendazim prothiocarb and etridiazole). The use of halogen donors is particularly preferred since we have found that plants in general can tolerate high levels of halogen and the risk of damage due to errors in dosing halogen donors may be less than with other forms of pathogenicide.

The halogen donors for present use include hypohalites, e.g. sodium or calcium hypochlorite, and organic compounds, e.g. halogenated alkylhydantoins, notably dibromo-dimethyl hydantoin, and sulphonchloramides, e.g. Chloramine T. However, particularly preferred halogen donors for present use are those of the general formula:



and hydrates thereof wherein X is halogen, notable chlorine or bromine; and M is selected from halogen or an alkali-metal. It is preferred that X and at least one M be chlorine. Suitable halogen donors thus include trichloroisocyanuric acid, monosodium dichloroisocyanurate, monopotassium dichloroisocyanurate; and hydrates thereof, notably the dihydrate of monosodium dichloroisocyanurate. The halogen donors may be used alone or in admixture with one another and may be used in their commercially available forms or purities. For example the donor may be used in association with cyanuric acid or a salt thereof.

The use of the dihydrate of monosodium dichloroiso cyanurate is especially preferred as this hydrate offers advantages in stability during storage and handling, notably when

used in admixture with fertilizer salts. The use of trichloroisocyanuric acid offers the advantage of a sustained release of chlorine over a period of time.

Suitable permanganates for present use include alkali-metal, alkaline-earth metal and/or ammonium permanganates, notably potassium or calcium permanganate. The permanganates may be used in their commercially available forms and purity.

The presence of the permanganate in the circulating nutrient solution will cause the solution to have a purple colour. Where there is insufficient permanganate to destroy oxidisable organisms in the water, the solution will revert to is non-permanganated colour (usually brownish). Thus, the colour of the nutrient solution offers a clear warning that the permanganate has been consumed and that there is a risk of infection in the solution.

The fertilizer composition for present use is one containing N, P and K compounds and is characterised in that it is a water soluble composition. Preferably at least 80% by weight of a 10g sample of the fertilizer composition is dissolved after shaking with 1 litre of deionised water at 25°C for 10 minutes. Thus, the fertilizer composition for present use typically contains ammonium, potassium and/or calcium nitrates, ammonium and/or potassium phosphate, magnesium sulphate and trace elements (e.g. copper sulphate, iron/ethylenediamine tetra-acetic acid complex, boric acid etc). If desired some of the fertilizer ingredients are added separately, e.g. as nitric acid and/or phosphoric acid feeds to the nutrient film system.

Where the fertilizer salts contain ammonia, this may combine with the available chlorine released by a halogen donor to form chloramines. We have found that chloramines provide a particularly preferred form of available chlorine for use in nutrient film systems since they have a slower action then uncombined available chlorine. Thus, chlorinating material persists in the water throughout its circulation without the need to add high initial levels of chlorine. Also, chloramines may cause less hardening of the plant cell structure than does uncombined chlorine.

Accordingly, the present invention provides a process for treating water in a nutrient film system which comprises incorporating chloramine into water fed to or circulating in the nutrient film system.

The chloramine is preferably monochloramine, although mixtures of mono and/or di-chloramine may be used. The chloramine is conveniently formed *in situ* in the water or in a separate vessel from which it is dosed at the desired rate into the water. The chloramine is formed by the reaction of chlorine of a chlorine donor (notably a compound of formula I) with ammonia or an ammonium salt. The ammonium salt is conveniently provided by an ingredient in the fertilizer composition, e.g. ammonium phosphate and/or ammonium sulphate. It is preferred to provide an excess of ammonium salt, e.g. greater than 2, preferably at least 5, molar % excess over that theoretically required to convert the available chlorine to monochloramine. The excess of ammonium salt also reduces the rate of decomposition of the chloramine and an excess of up to 500 molar percent of ammonium salt may be used, if desired.

The amount of pathogenicide material which is used will vary with the nature of the material and the infection which is to be treated. Thus it will usually be desired to maintain from 0.2 to 10 parts per million of available halogen in the nutrient solution in the nutrient film system where a halogen or halogen donor is used, from 0.3 to 20 ppm of the chloramine (expressed as monochloromine equivalent) or from 1 to 10 ppm of Mn equivalent. In general satisfactory results may be achieved when from 0.2 to 30 ppm of the active component of the pathogenicide are maintained in the nutrient solution. In general the fertilizer mixtures will contain iron and the pathogenicide will usually be present in from 50 to 200% by weight of the iron. The iron is typically present in from 0.5 to 2% by weight (expressed as Fe) of the fertilizer. Therefore the pathogenicide active ingredient will typically be present in from 0.25 to 4% by weight of total fertilizer composition.

The pathogenicide can be incorporated into the water fed to or circulating in the nutrient film system using a number of methods. Thus, it can be fed to the water separately from the fertilizer, e.g. by dosing the water with a suitable concentrate or by passing the water in contact with the solid pathogenicide. For example loose tablets of the pathogenicide can be placed in the sump tank of the nutrient film system, or a perforated net or tube containing the tablets can be suspended in the sump. Alternatively, the pathogenicide can be incorporated into the fertilizer formulation and this then dosed to the water, notably as a concentrate, optionally with one or more of the fertilizer ingredients being fed separately. In the case of chloramines these are most conveniently formed *in situ* in the nutrient solution by the reaction of a chlorine donor with an ammonium salt.

Where an aqueous solution, suspension or emulsion of the pathogenicide and/or of fertilizer ingredients is being dosed, this may be dosed by any suitable means, e.g. by

metering or proportionating pump or by feeding the concentrate or emulsion to the throat of a venturi in the water feed line or into the circulating nutrient solution in the nutrient film system. Preferably, the concentrate is fed to the sump tank or nutrient recycle line of the nutrient film system.

The pathogenicide can be admixed with a solid fertilizer composition, e.g. be included in granules or tablets containing the fertilizer ingredients. Such mixtures are preferably dry, but may contain up to 15% by weight overall of water of crystallisation and/or hydration. However, with some combinations of fertilizer salts and pathogenicides, it may be desired to isolate the salts from the pathogenicide. This may be achieved by providing the pathogenicide and/or the fertilizer salts with a coating, e.g. of a dust, oil, wax and/or polymer. This may have the incidental effect of delaying or sustaining the release of the pathogenicide or the fertilizer into the water.

Alternatively, the fertilizer and pathogenicide can be put up in a multi-compartment container having a partition separating the pathogenicide from the fertilizer ingredients. For example, the container takes the form of a cartridge to be inserted into a dispensing device, the cartridge having a transverse partition wall to separate the ingredients, which may be in tablet or granular form. The partition wall may be water soluble so as to permit intermingling of the water with all the contents of the cartridge to give a single outflow of nutrient solution containing pathogenicide. Alternatively, the partition may be water insoluble. In this case water will have to flow separately through each compartment of the cartridge. It may be possible to adjust the flow through each compartment separately and independently to achieve the desired dosage of pathogenicide and fertilizer nutrient into the water. It will be appreciated that the cartridge with a solid wall may be formed as two separate cartridges, one containing pathogenicide and the other containing fertilizer salts.

The term cartridge has been used herein to denote a container adapted to be mounted in a dispensing device and to release its contents to a stream of water flowing through or over the container. Thus, the cartridge may take the form of a metal or plastics mesh walled container to be immersed in a tank of water; a tubular member with water inlets and outlets; or other forms. The term cartridge is to be construed in the above description in this general sense. A typical cartridge and its use is illustrated in the accompanying drawings which are diagrammatic cross-sections through cartridges containing halogen donor and fertilizer ingredients.

The cartridge comprises a tubular metal or plastics body 1 as shown in Figure 1. The ends are closed with end caps 2. The tube or end caps are provided with apertures (temporarily sealed with tear off seals or by shrink wrapping the cartridge, to prevent escape of the contents). The cartridge is mounted in a suitable dispensing system for use. For example the cartridge may be suspended in a tank. e.g. in the sump tank or in a concentrate reservoir, where the apertures in the tube and end walls are sufficiently fine (e.g. less than 1 mm) for the rate of dissolution of the contents to be sustained over a period of time. Alternatively, the cartridge may be mounted in a through-flow chamber as shown in Figure 2. Water flows through the cartridge either transversely or longitudinally (as shown) to dissolve the contents. The rate of flow of water may be adjusted by suitable valve or proportioning means to give a predetermined rate of release of solution. Alternatively, the rate of flow of water through the cartridge is related to the rate of flow of nutrient solution in the nutrient film system to which the contents of the cartridge are to be added. For example the outlet of the chamber 3 is connected to a verturi section 4 in the recycle line of the nutrient film system. Make up water is drawn from the reservoir 5 via cartridge 1 into the verturi 4.

A typical mixture of plant nutrients and chlorine donor for use in the cartridge described above contains the following materials: potassium nitrate, calcium nitrate, potassium phosphate, magnesium nitrate, iron/ethylenediaminetetra-acetic acid complex, manganese sulphate, boric acid, copper sulphate and ammonium molybdate to provide 200 parts of nitrogen, 300 parts potassium, 60 parts phosphorus, 250 parts calcium, 50 parts magnesium, 12 parts of iron, 2 parts of manganese, 0.3 parts of boron, 0.1 parts of copper and 0.2 parts molybdenum; and 4 parts of the dihydrate of monosodium dichloroisocyanurate. Preferably this latter is used in the form of a tablet or as granules.

Where it is necessary to separate the chlorine donor from the fertilizer salts (notably where ammonium salts are present in the fertilizer salts) cartridge 1 may have a transverse wall 6 as shown dotted. This wall may be water soluble or readily disintegrated when wet (e.g. made from paper) or may be water resistant (e.g. made from metal or plastics).

Whilst the invention has been described above in terms of the use of a single pathogenicide, it is within the scope of the present invention to use mixtures of

pathogenicides. Thus a halogen donor can be used to sanitize the water in combination with a fungicide, e.g. that sold under the Trade Mark Benlate.

The invention will now be illustrated by the following Examples in which all parts and percentages are given by weight unless stated otherwise.

Example 1

An NFT system comprises nutrient solution being circulated through a trough from a header tank to a sump tank from whence it is pumped to the header tank. A nutrient solution and water are fed to the sump tank to make up the nutrients and water consumed by the plants growing in the trough. A perforated plastics tube is suspended in the sump tank so that solution flows through the perforations of the tube. Within the tube is held a tablet containing trichloroisocyanic acid and available under the Registered Trade Mark of FITAB. During the period of operation the available chlorine in the circulating nutrient solution varies between 5 ppm when a new tablet is put into the tube and less than 1 ppm when the tablet is largely consumed. In order to maintain the sanitising effect of the tablet, a new tablet is inserted into the tube when the available chlorine level falls below 1 ppm.

Example 2

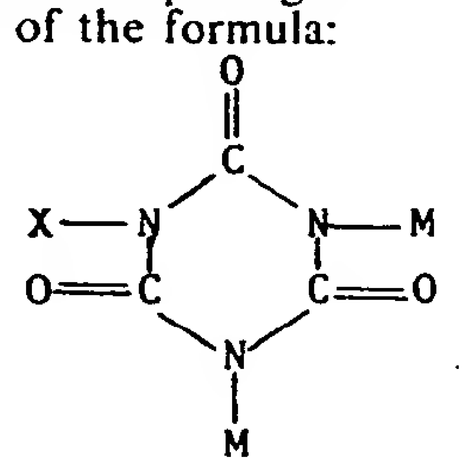
The process of Example 1 is repeated except that the chlorine donor is sodium dichloroisocyanurate and this is dissolved in water to give a concentrate. This aqueous concentrate is drip fed to the sump tank at such a rate as is required to maintain from 1 to 3 ppm of available chlorine in the circulating nutrient solution.

WHAT WE CLAIM IS:—

1. A process for treating water fed to or circulating in a nutrient film system which comprises incorporating a plant physiologically acceptable amount of a pathogenicide into the water.

2. A process as claimed in claim 1 wherein the pathogenicide is selected from halogens; halogen donors; permanganates; benzimidazoles and other fungicides.

3. A process as claimed in either of claims 1 or 2 wherein the pathogenicide is selected from those of the formula:



and hydrates thereof wherein X is halogen and each M is selected from halogen or an alkali-metal.

4. A process as claimed in any one of claims 1 to 3 wherein the halogen donor is selected from trichloroisocyanuric acid, monosodium dichloro isocyanurate, monopotassium dichloroisocyanurate and hydrates thereof.

5. A process as claimed in either of claims 1 or 2 wherein the pathogenicide is a chloramine.

6. A process as claimed in claim 5 wherein the chloramine is produced *in situ* by the reaction of chlorine or a chlorine donor with ammonia or an ammonium salt.

7. A process as claimed in claim 6 wherein the ammonium salt is used in an excess of from 2 to 500 molar percent over that theoretically required to convert the available chlorine into mono-chloramine.

8. A process as claimed in any one of the preceding claims wherein from 0.2 to 30 ppm of the active component of the pathogenicide are maintained in the water.

9. A process as claimed in any one of claims 1 to 7 wherein iron is also being incorporated into the water and the active component of the pathogenicide is incorporated at from 50 to 200% by weight of the iron expressed as Fe.

10. A process as claimed in any one of the preceding claims wherein the pathogenicide is fed to the water as a fluid concentrate.

11. A process as claimed in any one of claims 1 to 9 wherein the water is contacted with the pathogenicide in solid form.

12. A process as claimed in any one of the preceding claims wherein the pathogenicide is fed to the water in association with one or more fertilizer ingredients.

13. A process as claimed in any one of the preceding claims wherein the pathogenicide is incorporated into the nutrient solution circulating in the nutrient film system in the sump tank of the system or in the solution recycle line.

14. A process as claimed in claim 1 substantially as hereinbefore described.

15. A process as claimed in claim 1 substantially as hereinbefore described in any one of the Examples or as described with respect to the accompanying drawings.

T. I. P. DUMMETT,
Agent for the Applicants,
Chartered Patent Agent
Fisons Limited
Fison House
Princes Street, Ipswich
IP1 1QH Suffolk

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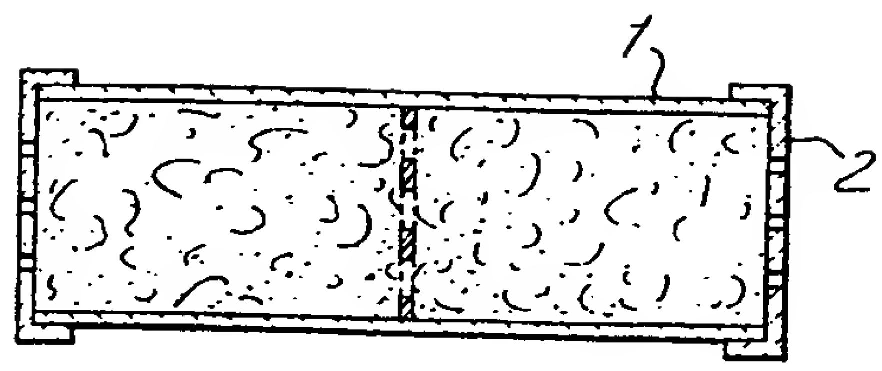

Fig 1

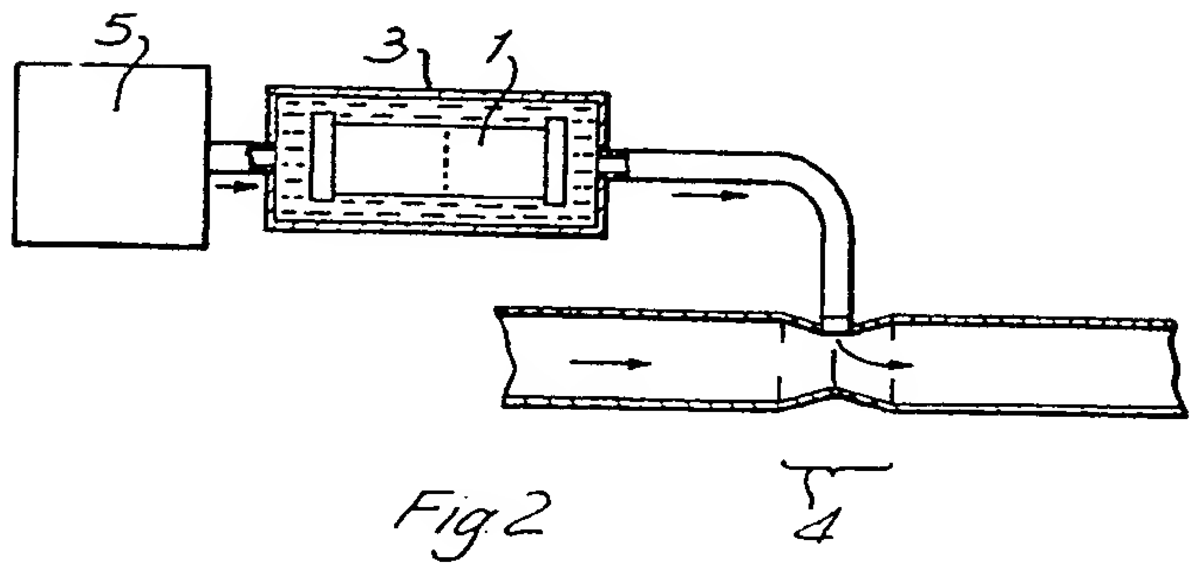

Fig 2

1600289 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

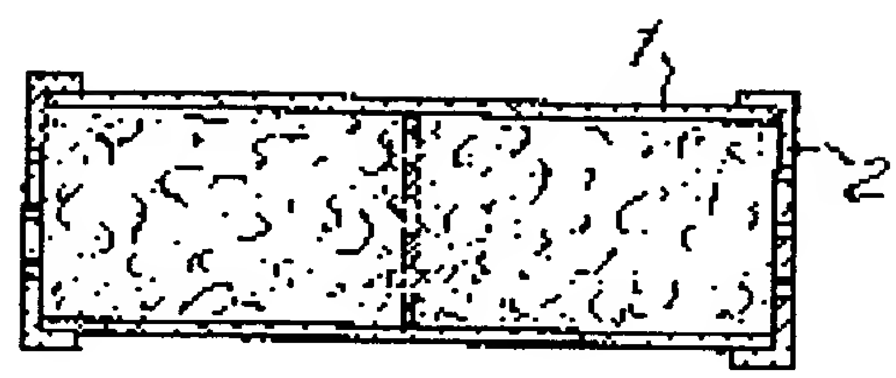

Fig 1

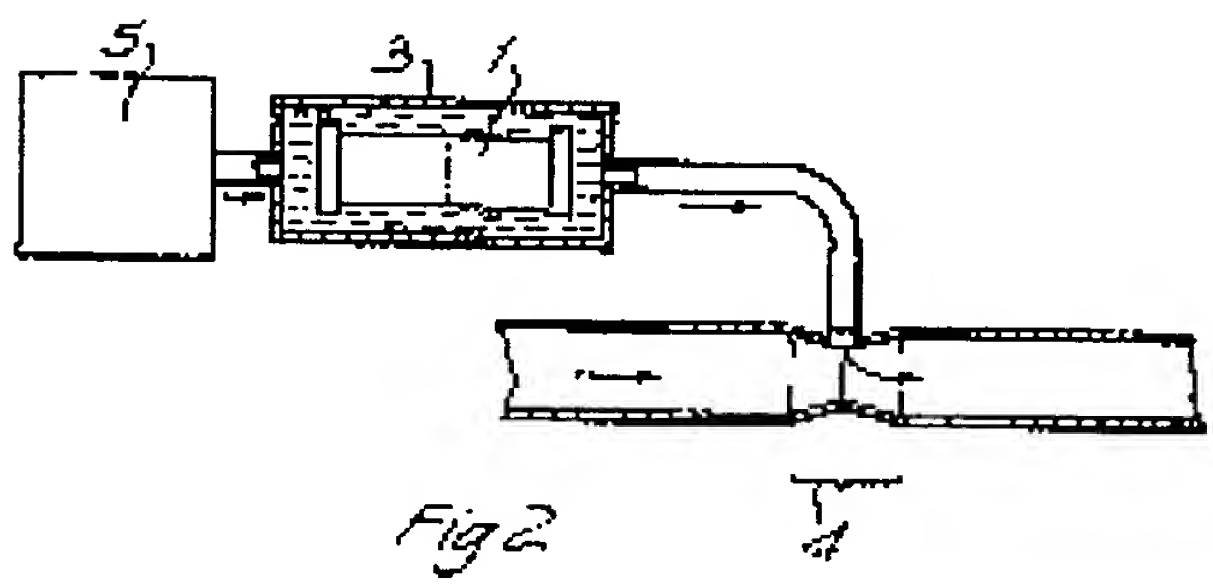

Fig 2